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Risk and time preferences:
Experimental and household survey data from Vietnam

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Abstract

We conducted experiments in Vietnamese villages to investigate how wealth, political history, occupation, and other demographic variables (taken from a comprehensive earlier household survey) are correlated with risk and time discounting measured in experiments. Experimental results show that in villages with higher mean income, people are less loss-averse and more patient. Villagers in the north who had worked on collective farms and received food from the government on a regular basis are less averse to loss.
We expand measurements of risk and time preferences beyond expected utility and exponential discounting, replacing those simple approximations with prospect theory and a three-parameter hyperbolic discounting model.

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A fundamental question in development economics is the extent to which economic success is linked to basic features of human preferences. If people are extremely averse to financial risk, they may be reluctant to create businesses that may have inherently risky cash flows. If people are impatient, they may be reluctant to invest and educate their children (as education is a long-term investment in future income). Taken together, risk-aversion and impatience may explain, in part, why some people remain poor.

We conducted experiments in Vietnamese villages to directly measure risk and time preferences of individuals, and investigated how these preferences correlate with economic circumstances. Vietnam has several advantages as a field site:

1. Access to a 2002 living standard survey conducted in Vietnam enabled us to link survey responses from individuals directly to experimental responses by the same individuals. Having the previous survey responses also enabled us to handpick a sample of villages with a wide range of average incomes to study the effect of cross-village income differences.

2. Many Vietnamese villagers are poor but literate. As a result, it is both easy to motivate them with modest financial stakes, and to ensure they comprehend experimental instructions.[1]

3. The recent rise of household businesses in the market economy has created substantial variation in occupation and household income. This occupation and income variation can be correlated with preference measures.

In any cross-sectional study like this, it is difficult to infer the direction of causality from correlation: Do preferences cause economic circumstances (e.g., through business formation, for example), or do circumstances create preferences (as described by Samuel Bowles (1998))? An ideal study would use randomized assignment of individuals to economic circumstances. As an alternative, we employ an instrumental variable

[1] According to the World Bank (2005), 45 percent of the rural population lives below the poverty line (p. 279). So modest experimental payments, by Western standards, amount to several days' wages. At the same time, the national literacy rate is around 90 percent (and is slightly higher in our sample), There are only three countries which are both poorer (lower GNP per capita) and more literate-- Kyrgyzstan, Tajikistan, and Uzbekistan (pp.292-293).

approach, using expenses for funerals and crop failure due to pests, which are unlikely to be correlated with preferences, as instrumental variables for income.

One fact about Vietnam can be also used to infer something about causality. In Vietnam, government policies strongly penalize inter-regional migration. Migrants are not recognized as permanent residents and cannot receive health care and public education. As a result, migration is rare (only six out of the 181 subjects in our study moved into their current villages in the last ten years). To the extent that people are stuck in their villages, any observed correlation between preferences and village economic variables is consistent with the interpretation that circumstances are causing preferences, rather than the other way around.[2]

Besides contributing new data, our paper makes a methodological contribution to experimental development economics. Most previous experiments conducted in the field tested simple models of risk and time preferences that can be characterized by one parameter. (The thorough review by Juan-Camilo Cardenas and Jeffrey Carpenter (2006) summarizes many of these studies). These simple models have often been rejected by experimental data in Western educated populations (Shane Frederick, George Loewenstein and Ted O'Donoghue, 2002, Chris Starmer, 2000) and by field data (Colin F. Camerer, 2000) in favor of models with multiple components of risk and time preferences. For example, in expected utility theory (EU), risk preferences are characterized solely by the concavity of a utility function for money. But if risky choices are expressions of prospect theory preferences (Daniel Kahneman and Amos Tversky, 1979), then utility concavity is not the only parameter influencing risk preferences—nonlinear weighting of probabilities, and aversion to loss compared to gain also influence risk preferences. Our instruments are designed to measure all three parameters in prospect theory, rather than just one in EU.

Similarly, we measure three parameters in a general time discounting model (Jess Benhabib, Alberto Bisin and Andrew Schotter, 2005), rather than just measuring a single exponential discount rate as in most other studies. If the simpler instruments are adequate approximations, then our richer instruments will deliver parameter values of the extra

[2] Of course, village circumstances may also be a vestige of history, development of local norms, or influences of particular leaders, which only a fuller historical ethnographic account could address.

variables which affirm the virtue of the simple instruments. Our results, in fact, indicate the extra parameters typically take on values which reject the simpler theories, and are correlated with individual differences in sensible ways.

Before proceeding to design details and results, it is useful to discuss how our approach compares to other field experiments. Field experiments in development are powerful tools for policy evaluation because they can randomize treatments in naturally-occurring decision making to see how well a specific policy works in a specific setting with a proper control group (see Esther Duflo (2005) for a review). For example, Nava Ashraf, Dean Karlan and Wesley Yin (2006) found that women who displayed lower discount rates in a hypothetical-question survey were more likely to open a commitment savings account offered by a rural bank in the Philippines.

Our approach is different. Our study is designed to collect preference measures experimentally and correlate those measures with many different demographic and economic variables (income, in particular) from the previous household survey. The goal is to contribute basic tools for field experimentation and to generate tentative observations about the correlation between preferences and economic circumstances. No single result will be as conclusive as more targeted studies which explore the effect of a specific policy. Nevertheless, the policy-specific approach and our broad approach are complementary. Targeted studies like Ashraf et al.'s tell broader studies like ours what to look for. Broader studies like ours give a rich set of tentative results for more targeted studies like Ashraf et al.'s to explore more carefully. Accumulation of regularity will come fastest from doing both types of studies.

We find that people in poorer villages are not necessarily more risk-averse, but they are more loss-averse. People living in poorer villages are also less patient. This suggests economic development could influence preferences; the wealthier the villages become, the less loss averse and more patient are the villagers. Furthermore, villagers in the north who had worked on collective farms and received food from the government on a regular basis are less averse to loss. This implies appropriate welfare policies can potentially reduce aversion to loss.

I. Selection of research sites and research methods

In July-August 2005, risk and time discounting experiments were conducted with members of households who were previously interviewed during a 2002 living standard measurement survey.[3] In the 2002 survey, 25 households were interviewed in each of 142 and 137 rural villages in the Mekong Delta (in the South) and the Red River Delta (in the North).[4] From these, we chose nine villages, five villages in the south and four villages in the north, with substantial differences in mean village income and market access. The nine villages were picked to create statistically powerful cross-village comparisons.

Some descriptive statistics about the nine experimental village sites are given in Table 1. The southern villages are indexed by S1 - S5 (where S1 indexes the highest village wealth and S5 indexes the lowest), and northern villages are indexed by N1 - N4.[5] The mean annual income in village S1 is 36.6 million dong (approximately 2,287 US dollars), while the mean income in village N4 is 7.2 million dong (450 US dollars).

A week before the experiments, research coordinators contacted local government officials in each research site, and asked them to invite one person from each of the 25 previously surveyed households to the experiments. Experiments started at approximately 9 A.M. in the morning, and lasted about four hours.[6] Subjects were given instructions and separate record sheets for each game. Illiterate subjects (8 percent) were given verbal instruction by research assistants. Subjects who had difficulty completing record sheets by themselves were also helped by research assistants who carefully avoided giving specific instructions about how to answer. The average experimental earning for three

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[3] A discrete trust game (Joyce Berg, John Dickhaut and Kevin McCabe, 1995) was conducted before the risk and time discounting experiments. The outcomes of trust game were not revealed until the end of the session.

[4] The 2002 living standard survey covers total 75,000 households in Vietnam. According to the local government officials in our research sites, lists of all households in selected villages were submitted to district offices, and households were randomly selected from the lists for the survey.

[5] Villages S1 and S3 are in Can Tho City, Village S2 is in Ca Mau Province, Villages S4 and S5 are in Tra Vinh Province, Villages N1 and N2 are in Vinh Phuc Province, and Villages N3 and N4 are in Thai Binh Province.

[6] Trust game, risk and time discounting experiments took approximately two hours, one hour and one hour, respectively.

games was 174,141 dong (about 11 dollars[7]), roughly 6 to 9 days' wages for casual unskilled labor.

II. Risk

A. Previous findings

Ravi Kanbur and Lyn Squire (2001) describe the risk attitude of the poor as "a feeling of vulnerability". Market fluctuations and natural disasters could put these villagers in a state of having little or losing what little they have. Empirical evidence suggests wealthier households invest in more risky productive activities, and earn higher returns (Mark R. Rosenzweig and Hans P. Binswanger, 1993). In theoretical models, it is often assumed that the rich landlord is risk-neutral while the poor tenant is risk-averse (Pranab Bardhan and Christopher Udry, 1999, Avishay Braverman and Joseph E. Stiglitz, 1982). These premises are consistent with decreasing absolute risk aversion in expected utility theory (EU); wealthier people are willing to take more risk than poorer people.

However, previous experimental studies conducted in developing countries give mixed results on wealth and risk preferences. Hans P. Binswanger (1980, 1981) and Paul Mosley and Arjan Verschoor (2005) find no significant association between risk aversion and income. Uffe Nielsen (2001) finds positive relations between wealth and risk aversion, while Matte Wik, Tewodros Kebede, Aragie Bergland and Stein Holsen (2004) and Mahmud Yesuf (2004) find negative correlations between wealth and risk aversion. However, they used EU and mix gain-only and gain-loss gambles in their analysis, making it difficult to tell whether risk aversion comes solely from the concavity of utility function. Observations from many experiments and the field suggest there is a disproportionate aversion toward loss compared to equal-sized gains (Colin F. Camerer, 2000).

B. Measurement of prospect theory parameters

We consider prospect theory as an alternative theoretical framework to EU, and conduct experiments with lotteries involving gains and losses (to measure loss-aversion). In EU, risk preferences are characterized solely by the concavity of a utility function.

[7] The exchange rate between Vietnamese Dong and US Dollar does not fluctuate very much. On July 23 2005, the exchange rate was 15,880 Dong for one US Dollar, while the exchange rate was 15,947 Dong for one Dollar on July 23, 2002.

Prospect theory suggests utility concavity is not the only parameter influencing risk preferences— nonlinear weighting of probabilities, and aversion to loss compared to gain also influence risk preferences.

We use cumulative prospect theory[8] and the one-parameter form of Drazen Prelec (1998)'s axiomatically-derived weighting function as follows:

$$U(x,p;y,q)=\begin{cases} v(y)+\pi(p)(v(x)-v(y)), & x>y>0 \quad or \quad x<y<0 \\ \pi(p)v(x)+\pi(q)(v(y)) & x<0<y \end{cases}$$

where $v(x)=\begin{cases} x^{\sigma} & \text{for} \quad x>0 \\ -\lambda(-x^{\sigma}) & \text{for} \quad x<0 \end{cases}$ and $\pi(p)=\exp[-(-\ln p)^{\alpha}]$

The expected prospect value over binary prospects consisting of the outcome x with the probability p and the outcome y with the probability q is denoted by $U(x,p;y,q)$. The function $v(x)$ denotes a power value function. Parameters σ and λ represent concavity of the value function, and the degree of loss aversion. The probability weighting function is linear if $\alpha=1$, as it is in EU. If $\alpha<1$, the weighting function is inverted S-shaped, i.e. individuals overweight small probabilities and underweight large probabilities, as shown by Amos Tversky and Daniel Kahneman (1992). If $\alpha>1$, then the weighting function is S-shaped, i.e. individuals underweight small probabilities and overweight large probabilities. We use Prelec's weighting function because it is flexible enough to accommodate the cases where individuals have either inverted-S or S-shaped weighting functions, and has fit previous data reasonably well.[9] The above model reduces to EU if $\alpha=1$ and $\lambda=1$.

To elicit the three prospect theory parameters, we designed three series of paired lotteries as shown in Table 2. Look at Series 1 first. Each row is a choice between two binary lotteries, A or B. We put 10 numbered balls in a bongo cage, and draw one ball from the cage after all subjects made decisions. Suppose a subject chooses A for the first

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[8] We follow the functional forms (1) and (2) in Kahneman and Tversky (1979).

[9] Harbaugh, Krause and Vesterlund (2002), and Leslie Real (1991) show that contrary to the standard assumption of prospect theory, children and bees have S-shaped weighting functions, underweighting small-probability outcomes and overweighting large-probability outcomes. (Real's study does not control for concavity of the utility of nectar, however, and may therefore misidentify curvature of the weighting function.) Steven J. Humphrey and Arjan Verschoor (2004) find that in Ethiopia, Indian and Uganda, some individuals make choices which are consistent with S-shaped weighting functions. However, they use only three probabilities (25, 50 and 75 percent) which may not be ideal choices to estimate nonlinear weighting of extreme probabilities.

row of Series 1, and the first row of Series 1 was selected for the actual payment. If the number 4 ball is drawn from the bingo cage, the subject will receive 10,000 dong.

We enforced monotonic switching by asking subjects at which question they would “switch” from Option A to Option B in each Series. They can switch to Option B starting with the first question (i.e., they can choose Option B in every row), and they do not have to switch to Option B at all.[10] After they completed three series of questions with the total of 35 choices, we draw a numbered ball from a bingo cage with 35 numbered balls, to determine which row of choice will be played for real money. We then put back 10 numbered balls in the bingo cage and played the selected lottery.

The difference in expected value between the lotteries (A relative to B) is shown in the right column. Notice as one moves down the rows, the higher payoff in Option B increases and everything else is fixed. Most individuals choose Option A in the first row and, as the high potential payoff in Option B increases going down the rows, switch to preferring B over A at some point. The largest payoff, 1.7 million dong (about 107 dollars), is equivalent to 24 percent of the annual mean income in Village N4. Series 2 is similar, but with different payoffs and probabilities. Series 3 involves both gains and losses.

The choices are carefully designed so any combination of choices in the three series determines a particular combination of prospect theory parameter values. Table 3 illustrates the combinations of approximate values of σ (parameter for the curvature of power value function), α (probability sensitivity parameter in Prelec’s weighting function), and λ (loss aversion parameter) for each switching point. “Never” indicates the cases in which a subject does not switch to Option B (i.e., always choose A). The switching points in Series 1 and 2 jointly determine σ and α. For example, suppose a subject switched from Option A to B at the seventh question in Series 1. The combinations of (σ,α) which can rationalize this switch are (0.4, 0.4), (0.5, 0.5), (0.6, 0.6), (0.7, 0.7), (0.8, 0.8), (0.9, 0.9) or (1, 1). Now suppose the same subjects also switched from Option A to B at the seventh question in Series 2. Then the combinations

[10] The instructions gave three examples. In one example a subject switches at the sixth question, in one example the subject chooses option A for all questions, and in one example the subject chooses Option B for all questions. The three examples were given to help ensure that subjects do not feel that they are forced to switch.

of (σ,α) which rationalize that switch are (0.8, 0.6), (0.7, 0.7), (0.6, 0.8), (0.5, 0.9), or (0.4, 1). By intersecting these parameter ranges from Series 1 and 2, we obtain the approximate values of (σ,α)=(0.7, 0.7).[11] Predictions of (σ,α) for all possible combinations of choices are given in Table A.1 in the Appendix. If a subject is an EU maximizer under the assumption of constant relative risk aversion (which is commonly assumed in the literature), the combinations of switching points in Series 1 and 2 are (7,1), (8,2), (9,3), (10,4), (11,5), (12,6), (13,7), (14,8), or (Never, 9).

The loss aversion parameter λ is determined by the switching point in Series 3. Notice that λ cannot be uniquely inferred from switching in Series 3; the range of λ values that are implied by each switching point depends on the utility curvature σ. However, questions in Series 3 were constructed to make sure that λ takes similar values across different levels of σ. Table 3 shows the range of λ for each switching point for three values of σ; σ=0.2, 0.6 and 1. The later they switch from A to B (i.e., for higher-numbered questions), the more averse they are to losses.[12]

Before proceeding to results, let us highlight our hypotheses. If prospect theory is a more appropriate model than EU, we expect α (probability sensitivity parameter) to be smaller than 1, and λ (loss aversion parameter) to be larger than 1. If EU is a suitable

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[11] When a subject switches from Option A to B at the seventh questions in both Series 1 and 2, the following inequalities should hold.
$10000^{\sigma}+\exp[-(-\ln .3)^{\alpha}](40000^{\sigma}-10000^{\sigma})>5000^{\sigma}+\exp[-(-\ln .1)^{\alpha}](125000^{\sigma}-5000^{\sigma})$,
$10000^{\sigma}+\exp[-(-\ln .3)^{\alpha}](40000^{\sigma}-10000^{\sigma})<5000^{\sigma}+\exp[-(-\ln .1)^{\alpha}](150000^{\sigma}-5000^{\sigma})$,
$30000^{\sigma}+\exp[-(-\ln .9)^{\alpha}](40000^{\sigma}-30000^{\sigma})>5000^{\sigma}+\exp[-(-\ln .7)^{\alpha}](65000^{\sigma}-5000^{\sigma})$, and
$30000^{\sigma}+\exp[-(-\ln .9)^{\alpha}](40000^{\sigma}-30000^{\sigma})<5000^{\sigma}+\exp[-(-\ln .7)^{\alpha}](68000^{\sigma}-5000^{\sigma})$.
The ranges of σ and α that satisfy the above inequalities are 0.65<σ<0.74 and 0.66<α<0.74. The point (σ,α)=(0.7, 0.7) satisfies the condition. When subjects do not switch, the approximate values at the boundaries were used. For example, if a subject never switches either in Series 1 or Series 2, the largest approximate values of σ and α that satisfy the following inequalities are used: $10000^{\sigma}+\exp[-(-\ln .3)^{\alpha}](40000^{\sigma}-10000^{\sigma})>5000^{\sigma}+\exp[-(-\ln .1)^{\alpha}](1700000^{\sigma}-5000^{\sigma})$ and $30000^{\sigma}+\exp[-(-\ln .9)^{\alpha}](40000^{\sigma}-30000^{\sigma})>5000^{\sigma}+\exp[-(-\ln .7)^{\alpha}](130000^{\sigma}-5000^{\sigma})$.

[12] Development economists sometimes consider "safety-first" decision rules which evaluate options by whether they have a less than p chance of some catastrophic loss L, and then apply another decision criterion to the choices which first pass that safety criterion. If L is between 4,000 and 21,000 such a rule will produce switching in the series 3 choices that will look like loss-aversion. It is difficult to separate safety-first and loss-aversion without having more structure on the form of the safety-first rule and a test to sharply distinguish them.

model, then α and λ won't be significantly different from 1. In addition, EU predicts that wealth is negatively correlated with risk aversion (decreasing absolute risk aversion).

C. Empirical results

Figure 1 shows the distributions of choices made by subjects in Series 1 and 2. The numbers in the axes correspond to the switching points in Series 1 and 2.[13] The height of a cone represents the number of subjects who switched at that particular combination of switching points in Series 1 and 2. Black cones represent the choices which are consistent with the constant relative risk aversion (CRRA) hypothesis of EU. Notice there are not many subjects whose choices are consistent with CRRA. Figure 2 shows the distributions of estimated σ and α. The mean estimated values of (σ, α) are (0.59, 0.74) and (0.63, 0.74) in the south and north, respectively.[14] The average derived value of α is significantly different from 1 at the 1% significance level by t-test, implying our experimental results reject EU in favor of inverted-S shaped probability weighting.

We regressed the curvature of the utility function (σ) using OLS regressions, and loss-aversion (λ) by interval regressions using maximum likelihood techniques against individual-specific variables. We first ran regressions using absolute income as an independent variable. The regression results are shown in columns (1) and (3) in Table 4 (See Table 5 for variable definitions). Looking first at σ (curvature of the utility function), the strongest effects suggest subjects who are more educated, elder and those living far from markets are more risk-averse (i.e., negative effect on σ), and fishermen[15] are less risk-averse (i.e., positive effect on σ). The estimation result for loss aversion (λ) shows ethnic Chinese and government officers are less loss averse and people living in the South are more loss averse. The effect of the South variable suggests the possible

[13] Switching point 15 implies the subject never switched in that series.

[14] Tversky and Kahneman's (1992) estimated values of σ and α are 0.88 and 0.61, respectively, using a different weighting function than we used (the single-parameter TK version) and a very different procedure. However, Prelec's weighting function and the TK weighting function yield nearly identical results. George Wu and Richard Gonzales's (1996) estimated values of σ and α (using the power value function and the Prelec function as we do) are 0.48 and 0.74. Ming Hsu, Chen Zhao and Camerer (2007) review these studies and nine others which show rather reliable estimates, along with brain activity correlated with α (see also Henry Stott (2006)).

[15] Håkan Eggert and Peter Matinsson (2004) found that Swedish fishermen act as if they have linear monetary utility.

influence of political regime.[16] People in the north worked on collective farms for many years, and the government provided them with food for subsistence, so the social safety net may be reflected in less aversion to losses. The income variable is not significantly correlated with either the curvature of the utility function (σ) or loss aversion (λ).

The distribution of estimated λ is shown in Figure 2. The average value of λ is 2.63. It is close to the 2.25 estimated by Tversky and Kahneman (1992), and is significantly different from one, rejecting EU, even by the most conservative sign test (91% of the observations are greater than one, $p<.001$).

Having learned that income does not explain either risk aversion (in terms of concavity of utility function) or loss aversion, we decomposed income into two variables, relative income within the village and mean village income. The relative income variable is constructed as follows:

$$\text{Relative income} = \frac{\text{Household income} - \text{Mean village income}}{\text{Standard deviation of income within the village}}$$

Columns (2) and (4) in Table 4 contain the regression results of the estimations. Neither relative income nor mean income of the village explains the concavity of utility function. However, mean village income is strongly correlated with loss aversion. This is consistent with the idea that wealthy villages provide "social insurance" which spreads risks of loss among villagers, and decreases loss aversion.

We also conducted instrumental variable two-stage least squares (IV-2SLS) regressions because income might cause preference, or preference might cause income. It is useful to have an exogenous cause of income as an instrument to disentangle causality. We used the costs of funeral and crop failure due to pests as exogenous instruments for income in the regressions.[17] The variable "crop failure due to pests" is a dummy variable, taking the value 1 if the commune officials reported it to the surveyor in 2002. We use the relative costs of funerals as an instrument for relative income, and failure due to pests as an instrument of mean village income.

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[16] Terry A. Rambo(1973) reports that the social structures were different in the North and South before communism. It is possible that Northern villages have a stronger social safety net system by tradition.

[17] We first tested four instrumental variables, funeral costs, natural disaster relief, the crop failure due to natural disaster and pests, and selected funeral costs and crop failure due to pests as instruments, since these variables had the highest correlation with the income variable.

The IV regression results are shown in Table 6. The effects on σ and λ noted in Table 4 are still present. All the income variables (absolute, relative, and mean village income) are now significant in the regressions of loss aversion. Individuals with high absolute income, higher relative income within the village and those living in wealthier villages are less loss averse. Mean village income shows a relatively stronger effect than relative income, which may indicate strong village-level social insurance effects that may mitigate aversion to loss.

III. Time discounting

A. Previous findings

Time discounting is another fundamental preference which may affect wealth accumulation. Most studies linking discount rates to wealth in both developed and developing societies use the exponential discounting model and show richer people are more patient (lower r).[18] Jerry Hausman (1979), Emily C. Lawrance (1991) and Glenn W. Harrison, Marten I. Lau and Melonie B. Williams (2002) report this relation in the United States and Denmark. John L. Pender (1996), Nielsen (2001) and Yesuf (2004) also report it in India, Madagascar, and Ethiopia, respectively. Kris N. Kirby et al. (2002) and C. Leigh Anderson et al. (2004) did not find a wealth-patience relation in Bolivia and Vietnam, but their villages did not have as much income variation as we were able to design in by handpicking villages. However, exponential discounting model is often rejected by experimental and field data (Shane Frederick, George Loewenstein and Ted O'Donoghue, 2002). For example, measured discount rates tend to decline over time[19] (George Ainslie, 1992) and exhibit a "present bias" or preference for immediate reward.[20] Laibson (1997) proposed an elegant (β, δ) "quasi-hyperbolic" discounting model. The two β and δ parameters separate present bias and tradeoff between future time points.[21]

[18] Gary S. Becker and Casey B. Mulligan (1997) constructed a model which predicts how wealth affects time preferences, making richer people more patient.

[19] See Richard Thaler (1981), Uri Benzion et al. (1989), George Loewenstein and Drazen Prelec (1992), and John L. Pender (1996).

[20] See Laibson (1997), Laibson et al. (1998), O'Donoghue and Rabin (1999), and Angeletos et al. (2001).

[21] This simple formulation has been used to study procrastination, retirement planning, deadlines, addiction, and gym membership (B. Douglas Bernheim, Jonathan Skinner and Stephen Weinberg, 2001, Stefano DellaVigna and Ulrike Malmendier, 2006, Peter Diamond and Botond

B. Measurement of time discounting parameters

We use a general model proposed by Jess Benhabib, Alberto Bisin and Andrew Schotter (2005) which allows us to test exponential, hyperbolic, quasi-hyperbolic discounting, and a more general form. In our experiments, we give a long series of choices between smaller rewards delivered today, and larger rewards delivered at specified times in the future. This battery of pairwise choices permits estimation of their clever three-factor model. The model values a reward of y at time t according to yD(y,t) where

$$yD(y,t) = \begin{cases} y & if \quad t = 0 \\ \beta(1-(1-\theta)rt)^{\frac{1}{1-\theta}} y & if \quad t > 0 \end{cases} \qquad (1)$$

The three factors r, β and θ separate conventional time discounting (r), present-bias (β) and hyperbolicity (θ) of the discount function. When θ=1 and β=1, the equation reduces to exponential discounting. When θ=2 and β=1, it reduces to true hyperbolic discounting. When θ=1 and β is free, it reduces to quasi-hyperbolic discounting. When θ>2 the function is "hyper-hyperbolic"—the second derivative of the discount factor D(y,t) is even higher than for a hyperbolic (i.e., the weight on future rewards drops even more steeply than in a hyperbolic function). The three-parameter form enables a way to compare three familiar models at once.

We used 15 combinations of y and t in the experiments, i.e. 30,000, 120,000 and 300,000 dong with the delays of one week, one month and three months, and 60,000 and 240,000 dong with the delays of three days, two weeks and two months (see Table A.2 in the Appendix for all combinations). The largest amount of y, 300,000 dong (about 19 dollars), is equivalent to 15 days of wage in the rural north.

For each (y,t) combination, we asked five questions, with x equal to 1/6, 1/3, 1/2, 2/3, and 5/6 of the value of y. Subjects were presented with a total of 75 choices between two options:

Option A: Receive x dong today.

Option B: Receive y dong in t days.

Koszegi, 2003, David I. Laibson, Andrea Repetto and Jeremy Tobacman, 1998, O'Donoghue and Rabin, 1999, 2001)

Subjects gave a switching point from preferring A to B in each series of five questions. Before conducting the experiment, we publicly suggested a trusted agent who would keep the money until delayed delivery date to ensure subjects believed the money would be delivered. The selected trusted persons were usually village heads or presidents of women's associations. In some villages, the trusted agents were also experimental subjects. Agreement letters of money delivery were signed between the trusted agents and the first author. Agents were instructed to deliver the money to the houses of experimental subjects, which equalizes the pure transaction costs of receiving money immediately (i.e., at the end of the experiment) or in the future. In small villages like these there is a high level of trust and no subject expressed any concern about not getting future delivery of their money. Furthermore, if the subjects thought they could choose a large delayed reward, but actually receive the money earlier than the delayed period, they would appear to be patient; the results show that they generally did not. After subjects completed all 75 questions, we put 75 numbered balls in the bingo cage and drew one ball to determine which pairwise choice would be paid. The option chosen for that question (i.e. A or B) determined how much money was to be delivered, and when.

Denote the probability of choosing immediate reward of x over the delayed reward of y in t days by P(x>(y,t)), and use a logistic function to describe this probabilistic relation as follows:

$$P(x > (y,t)) = \frac{1}{1 + \exp(-\mu(x - y\beta(1-(1-\theta)rt)^{\frac{1}{1-\theta}}))} \tag{2}$$

We estimate the parameters μ, β, θ and r in the above logistic function. For example, if a subject chose to receive 120,000 dong in 1 week over 20,000 dong of immediate reward (choosing A) and switch to B when the immediate reward is increase to 40,000, then the dependent variable for the first response is 1 and the dependent variable for the second response is 0. The variable μ is a response sensitivity or noise parameter. For each subject, there are thirty observations, two observations for just before and after the switching point for each of fifteen series of questions.

C. Empirical results

Estimation results comparing specific functions are given in Table 7. We fitted the logistic function (2) by using a nonlinear least-squares regression procedure.[22] In addition to the general model (1) (shown in the far right column), we estimated restrictions of exponential discounting (θ=β=1), hyperbolic discounting (θ=2, β=1), and (β, δ) quasi-hyperbolic discounting (θ=1). Estimating the full model (1) with unrestricted θ gives a surprisingly high value of θ (5.07, similar to Benhabib et al's estimates) and influences the estimates of r and β but does not improve R^2 much, so we focus attention on the (β, δ) model of quasi-hyperbolic discounting, with θ=1 imposed.

Next, we estimate the following logistic function (3) to investigate whether demographic variables explain individual difference in present bias (β) and discount rates (δ).

$$P(x > (y,t)) = \frac{1}{1 + \exp(-\mu(x - y\beta \exp[-rt]))} \qquad (3)$$

where $\beta = \beta_0 + \sum \beta_i X_i$ and $r = r_0 + \sum r_i X_i$

Demographic variables of interest and their estimators are represented by X_i and β_i or r_i, respectively.

Table 8 shows the results from regressing estimates of the (β, δ) model of quasi-hyperbolic discounting, allowing ß and r to depend on demographic variables. We conducted non-linear estimations of the logistic function (3), using absolute income as an independent variable for the first regression (reported in column (1)), and relative and mean village income as independent variables for the second regression (reported in column (2)).[23] In order to obtain robust variance estimates with repeated observations on individual subjects, we specified that the observations are independent across

[22] We dropped data of 3 subjects, since they totally randomized their choices. We used data from all other subjects, including inconsistent choices they made. Inconsistency means that a subject would accept a longer delay of a larger amount y, rather than taking x earlier, but would not wait for a shorter delay for the same y and x (For example, if an agent chooses 10,000 dong today over 60,000 dong with three days of delay, but is willing to wait 2 months to receive 60,000 dong rather than receiving 10,000 dong today, their answers are inconsistent).

[23] The estimated coefficients of explanatory variables for r (discount rates) are multiplied by 100.

observations, but not within subjects (i.e., standard errors were adjusted for within-subject correlation).

The largest effects are on discount rates r. Age, absolute income and mean village income are positively related with patience (lower r). Individuals who trade are more patient (lower r) but those engaged in family businesses are more present-biased (lower β). W. Kip Viscusi and Michael J. Moore (1989) assert that risky but high-paying jobs may attract individuals with high discounting, which may explain the correlation between family business and present bias. Of course, since occupation choice is partly endogenous, it is difficult to know whether preferences influence occupation choice or vice versa. None of the income variables explain individual difference in present bias (β) while the estimated coefficient of β in Table 7 (0.644) indicates subjects are present biased. This implies people are present biased regardless of their wealth, and the degree of present bias is comparable to estimates from a variety of other studies.[24]

The amount of money made in the risk game earlier in the experimental session is correlated with patience: individuals who received higher payments in the risk game exhibit lower discount rates r. The choices made by the individuals who were assigned the role of money delivery were not significantly different from other subjects. We also conducted regressions using instrumental variables for income. Table 9 shows the estimation results. The regression results from the instrumental variable estimations are not substantially different from the ones without instruments.

IV. Conclusion

We conducted experiments in Vietnamese villages to investigate how wealth, political history, occupation, and other demographic variables are correlated with risk and time discounting measured in experiments.

Our results suggest either villager income or mean village income are strong factors determining risk and time preferences. People living in poor villages are not necessarily afraid of uncertainty, in the sense of income variation; instead, they are averse to loss. From time discounting experiment, we found the income and mean village

[24] See Alexander L. Brown, Colin F. Camerer and Zhikang Eric Chua (2006) for a review of the (β, δ) model estimates.

income are correlated with lower discount rates. Thus, people living in wealthier villages are not only less loss averse, but also more patient. This pattern implies that increasing village wealth or providing safety net may mitigate loss aversion and impatience. Our results also demonstrate that people are present biased regardless of their wealth. It suggests that policies could usefully focus not on increasing patience or subsidizing savings, per se, but on providing present-biased villagers with external commitment (as in Ashraf, Karlan and Yin (2006)). In addition, we found villagers in the north who had worked on collective farms and received food from the government on a regular basis are less averse to loss. This implies appropriate welfare policies can potentially reduce aversion to loss.

These results are exploratory and the experimental measures are not perfect. Furthermore, in a cross-sectional study like this, it is difficult to conclude very much about the direction of causality between preferences and economic circumstances because the study was not designed to do so. We used instrumental variables to deal with the income endogeneity problem, using funeral costs and pest loss shocks to instrument for relative income and mean village income, respectively. Of course, preferences and circumstances may be formed interdependently. However, the fact that income variables and IV income measures yield similar results tend to suggest that mean village income influences preferences rather than preferences influencing mean village income.

Finally, one contribution of our study is to show some advantages of expanding measurements of risk and time preferences beyond expected utility and exponential discounting, replacing those simple approximations with prospect theory and the Benhabib et al. three-parameter discounting model. In a poor, highly literate country, our subjects made comprehensible choices in a large battery of tasks while highly motivated to earn money. While these experiments take time, subjects in these sites are eager to participate and their opportunity cost of participating is low. As a result, these subjects will sit patiently and answer questions studiously while many dimensions of their economic life are measured. The experimental facts that are produced, and the interesting correlations that result, suggest that these instruments could be used in many other sites as well.

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Table 1: Descriptive statistics

	S1	S2	S3	S4	S5	N1	N2	N3	N4
Number of Subjects	22	16	18	21	21	17	22	24	20
Of which ethnic Chinese	9	1	0	0	0	0	0	0	0
Mean household income in 2002 (in 1 million dong)	36.6	35.8	20.3	18.5	15.0	28.0	17.5	9.1	7.2
Age (mean)	47.7	44.6	48.8	42.8	47.9	55.1	42.5	49.9	48.6
Gender (1=male) (mean)	0.59	0.88	0.83	0.71	0.81	0.47	0.36	0.50	0.50
Education (years) (mean)	7.2	7.1	8.4	6.0	5.0	7.5	8.0	4.8	7.6
Literacy rate (mean)	0.95	0.94	0.95	0.95	0.91	0.89	0.95	0.83	0.90
Main occupation of the subject in percent (multiple answers allowed, so columns do not sum up to 100)									
Farming	0	13	17	91	77	6	0	83	75
Livestock	5	19	56	50	32	6	45	54	10
Fishery	0	94	22	9	9	0	0	17	0
Trade	36	0	0	5	5	28	14	8	5
Business	23	0	17	0	5	6	14	8	10
Government officer	9	19	22	14	14	22	18	25	10
Casual work	27	0	11	5	14	0	5	17	10
Not working	23	0	17	0	9	50	9	8	15
Village-level data from the 2002 Living Standard Measurement Survey (sample: 25 households)									
Distance to nearest market	0.0	5.0	0.0	4.2	0.0	0.0	1.0	3.0	0.3
Daily wage for male labor for harvesting (1000 dong)	-	-	30	30	30	18	18	20	20

Table 2: Three series of pairwise lottery choices

Option A		Option B		Expected payoff difference (A-B)
Series 1				
Balls No.1-3	Balls No.4-10	Ball No.1	Balls No.2-10	
40,000	10,000	68,000	5,000	7,700
40,000	10,000	75,000	5,000	7,000
40,000	10,000	83,000	5,000	6,200
40,000	10,000	93,000	5,000	5,200
40,000	10,000	106,000	5,000	3,900
40,000	10,000	125,000	5,000	2,000
40,000	10,000	150,000	5,000	-500
40,000	10,000	185,000	5,000	-4,000
40,000	10,000	220,000	5,000	-7,500
40,000	10,000	300,000	5,000	-15,500
40,000	10,000	400,000	5,000	-25,500
40,000	10,000	600,000	5,000	-45,500
40,000	10,000	1,000,000	5,000	-85,500
40,000	10,000	1,700,000	5,000	-155,500
Series 2				
Balls No.1-9	Ball No.10	Balls No.1-7	Balls No.8-10	
40,000	30,000	54,000	5,000	-300
40,000	30,000	56,000	5,000	-1,700
40,000	30,000	58,000	5,000	-3,100
40,000	30,000	60,000	5,000	-4,500
40,000	30,000	62,000	5,000	-5,900
40,000	30,000	65,000	5,000	-8,000
40,000	30,000	68,000	5,000	-10,100
40,000	30,000	72,000	5,000	-12,900
40,000	30,000	77,000	5,000	-16,400
40,000	30,000	83,000	5,000	-20,600
40,000	30,000	90,000	5,000	-25,500
40,000	30,000	100,000	5,000	-32,500
40,000	30,000	110,000	5,000	-39,500
40,000	30,000	130,000	5,000	-53,500
Series 3				
Balls No.1-5	Balls No.6-10	Balls No.1-5	Balls No.6-10	
25,000	-4,000	30,000	-21,000	6,000
4,000	-4,000	30,000	-21,000	-4,500
1,000	-4,000	30,000	-21,000	-6,000
1,000	-4,000	30,000	-16,000	-8,500
1,000	-8,000	30,000	-16,000	-10,500
1,000	-8,000	30,000	-14,000	-11,500
1,000	-8,000	30,000	-11,000	-13,000

Table 3: Switching point (question at which preference switches from option A to option B) and approximations of σ, α and λ

Series 1 (Question 1-14)

σ \ α	.4	.5	.6	.7	.8	.9	**1**
.2	9	10	11	12	13	14	**never**
.3	8	9	10	11	12	13	**14**
.4	7	8	9	10	11	12	**13**
.5	6	7	8	9	10	11	**12**
.6	5	6	7	8	9	10	**11**
.7	4	5	6	7	8	9	**10**
.8	3	4	5	6	7	8	**9**
.9	2	3	4	5	6	7	**8**
1	1	2	3	4	5	6	**7**

Series 2 (Question 15-28)

σ \ α	.4	.5	.6	.7	.8	.9	**1**
.2	never	14	13	12	11	10	**9**
.3	14	13	12	11	10	9	**8**
.4	13	12	11	10	9	8	**7**
.5	12	11	10	9	8	7	**6**
.6	11	10	9	8	7	6	**5**
.7	10	9	8	7	6	5	**4**
.8	9	8	7	6	5	4	**3**
.9	8	7	6	5	4	3	**2**
1	7	6	5	4	3	2	**1**

Bold indicates choices compatible with EU (α=1) and risk-aversion.

Series 3 (Question 29-35)

Switching question	σ=0.2	σ=0.6	σ=1
1	$\lambda>0.14$	$\lambda>0.20$	$\lambda>0.29$
2	$0.14<\lambda<1.26$	$.20<\lambda<1.38$	$0.29<\lambda<1.53$
3	$1.26<\lambda<1.88$	$1.38<\lambda<1.71$	$1.53<\lambda<1.71$
4	$1.88<\lambda<2.31$	$1.71<\lambda<2.25$	$1.71<\lambda<2.42$
5	$2.31<\lambda<4.32$	$2.25<\lambda<3.73$	$2.42<\lambda<3.63$
6	$4.32<\lambda<5.43$	$3.73<\lambda<4.82$	$3.63<\lambda<4.83$
7	$5.43<\lambda<9.78$	$4.82<\lambda<9.13$	$4.83<\lambda<9.67$

Table 4: Correlations with dimensions of risk aversion

	σ (Value function curvature)		λ (Loss aversion)	
	(1)	(2)	(3)	(4)
Chinese	0.047	0.037	-3.885 **	-2.958 *
	(0.117)	(0.119)	(1.770)	(1.770)
Age	-0.005 **	-0.004 *	0.034	0.037
	(0.002)	(0.002)	(0.031)	(0.031)
Gender	-0.042	-0.035	-0.404	-0.503
	(0.055)	(0.055)	(0.789)	(0.778)
Education	-0.017 **	-0.017 **	0.111	0.144
	(0.008)	(0.008)	(0.110)	(0.110)
Farm/livestock	0.019	0.034	-0.223	-1.132
	(0.056)	(0.060)	(0.812)	(0.960)
Fishery	0.315 ***	0.307 ***	-1.132	-0.395
	(0.095)	(0.095)	(1.394)	(1.406)
Trade	-0.016	-0.011	1.140	1.541
	(0.078)	(0.078)	(1.097)	(1.112)
Business	0.038	0.011	-0.292	-0.155
	(0.086)	(0.086)	(1.246)	(1.226)
Government officer	0.053	0.055	-1.832 *	-1.857 *
	(0.073)	(0.073)	(1.056)	(1.038)
Income	-0.002		-0.026	
	(0.001)		(0.018)	
Relative Income		-0.025		-0.458
		(0.027)		(0.377)
Mean Income		-0.002		-0.131 ***
		(0.004)		(0.057)
Distance to market	-0.038 **	-0.038 **	-0.018	0.005
	(0.017)	(0.017)	(0.243)	(0.240)
South	-0.047	-0.046	1.473 **	2.307 **
	(0.056)	(0.065)	(0.807)	(0.914)
Constant	1.033 ***	1.029 ***	0.913	2.560
	(0.153)	(0.171)	(2.192)	(2.391)
Observations	181	181	181	181
Adjusted R^2	0.070	0.058		
Log pseudolikelihood			-434	-431

Note: *** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level. Standard errors are in parentheses.

Table 5: Variable definitions

Variable name	Description
Age	Age of the subject
Gender	Gender of the subject (1=male)
Education	Number of years the subject attended school
Farm/livestock	Subject's main occupation is farming or raising livestock
Fishery	Subject's main occupation is fishing
Trade	Subject's main occupation is trading
Business	The subject is engaged in household business
Government officer	The subject works for a local government
Income	Subject's household income (billion dong)
Relative Income	The difference between subject's household income and mean income of the village divided by the standard deviation of income within the village
Mean village income	Mean household income of the village (billion dong)
Distance to market	Distance to the nearest local market (km)
Trusted agent	The subject is a trusted agent of delayed delivery of money
Risk Payment	The amount of money the subject earned earlier from risk experiment

Table 6: Correlations with dimensions of risk aversion (IV income estimates)

	σ (Value function curvature)		λ (Loss aversion)	
Chinese	0.027	0.037	-4.662**	-4.515**
	(0.119)	(0.119)	(1.759)	(1.744)
Age	-0.005**	-0.004*	0.034	0.035
	(0.002)	(0.002)	(0.030)	(0.030)
Gender	-0.037	-0.035	-0.381	-0.378
	(0.055)	(0.055)	(0.770)	(0.766)
Education	-0.018**	-0.017**	0.135	0.138
	(0.008)	(0.008)	(0.107)	(0.107)
Farm/livestock	0.020	0.034	-0.686	-0.689
	(0.057)	(0.060)	(0.812)	(0.837)
Fishery	0.291***	0.307***	-1.548	-1.286
	(0.094)	(0.095)	(1.365)	(1.358)
Trade	-0.009	-0.011	1.285	1.376
	(0.078)	(0.078)	(1.071)	(1.070)
Business	0.014	0.011	-0.739	-0.698
	(0.086)	(0.086)	(1.206)	(1.198)
Government officer	0.058	0.055	-1.867*	-1.898*
	(0.073)	(0.073)	(1.038)	(1.030)
Income (IV)	-0.004		-0.200***	
	(0.004)		(0.062)	
Relative Income (IV)		-0.127		-2.468**
		(0.079)		(1.119)
Mean village income (IV)		-0.001		-0.187***
		(0.005)		(0.072)
Distance to market	-0.038**	-0.039**	-0.066	-0.107
	(0.017)	(0.017)	(0.239)	(0.238)
South	-0.024	-0.055	3.201***	2.861***
	(0.070)	(0.072)	(0.991)	(0.996)
Constant	1.072***	0.992***	3.735	3.611
	(0.169)	(0.187)	(2.339)	(2.584)
Observations	181	181	181	181
Adjusted R^2	0.062	0.066		
Log pseudolikelihood			-429	-429

Note: *** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level. Standard errors are in parentheses.

Table 7: Comparison of exponential, hyperbolic and quasi-hyperbolic discounting models

	Exponential	Hyperbolic	Quasi-hyperbolic	Equation (1)
μ ($x10^{-6}$)	6.26^{***}	7.60^{***}	8.58^{***}	8.70^{***}
	(.319)	(.408)	(.544)	(.553)
r	0.021^{***}	0.046^{***}	0.008^{***}	0.078
	(0.001)	(0.004)	(0.001)	(0.074)
β			0.644^{***}	0.820^{***}
	β=1	β=1	(0.019)	(0.070)
θ				5.070^{***}
	θ=1	θ=2	θ=1	(0.659)
Observations	5340	5340	5340	5340
Adjusted R^2	0.515	0.519	0.522	0.523

Note: *** Significant at the 1% level. Robust standard errors are in parentheses.

Table 8: Correlations with present bias and discount rates

	β (Present bias)		r (Discount rate)	
	(1)	(2)	(1)	(2)
μ ($x10^{-6}$)	9.18 ***	9.34 ***		
	(0.61)	(0.63)		
Constant (β_0, r_0)	0.701 ***	0.721 ***	0.023 ***	0.029 ***
	(0.113)	(0.130)	(0.004)	(0.005)
Chinese	-0.040	-0.052	0.056	0.063
	(0.081)	(0.085)	(0.349)	(0.347)
Trusted Agent	-0.034	-0.034	-0.133	0.006
	(0.082)	(0.085)	(0.223)	(0.236)
Age	0.001	0.001	-0.015 ***	-0.014 **
	(0.002)	(0.002)	(0.006)	(0.006)
Gender	0.003	-0.002	-0.116	-0.199
	(0.039)	(0.040)	(0.142)	(0.136)
Education	-0.007	-0.007	-0.027	-0.024
	(0.006)	(0.006)	(0.018)	(0.017)
Farm/livestock	-0.020	-0.027	-0.012	-0.381 **
	(0.044)	(0.057)	(0.153)	(0.171)
Fishery	0.051	0.055	-0.084	0.088
	(0.083)	(0.086)	(0.248)	(0.285)
Trade	-0.047	-0.019	-0.443 ***	-0.282 *
	(0.051)	(0.052)	(0.153)	(0.152)
Business	-0.135 *	-0.136 *	0.032	-0.070
	(0.069)	(0.071)	(0.192)	(0.213)
Government officer	-0.041	-0.039	-0.295	-0.257
	(0.050)	(0.050)	(0.186)	(0.180)
Income	0.638		-5.236 ***	
	(0.869)		(1.841)	
Relative Income		0.008		0.037
		(0.021)		(0.074)
Mean Village Income		0.061		-38.893 ***
		(3.103)		(8.379)
Distance to market	0.007	0.006	0.002	0.001
	(0.016)	(0.016)	(0.048)	(0.048)
South	-0.055	-0.048	-0.163	0.164
	(0.046)	(0.050)	(0.146)	(0.163)
Risk Payment	-1.059	-1.063	-8.369 **	-6.263 *
	(1.092)	(1.179)	(3.730)	(3.597)

Note: Number of observation is 5340 and adjusted R^2 is 0.524 in both regressions.
Note: *** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level. Standard errors are in parentheses.

Table 9: Correlations with present bias and discount rate (IV income estimates)-

	β (Present bias)		r (Discount rate)	
	(1)	(2)	(1)	(2)
μ (x10^{-6})	9.13***	9.27***		
	(0.61)	(0.63)		
Constant (β_0, r_0)	0.729***	0.704***	0.026***	0.036***
	(0.131)	(0.143)	(0.005)	(0.006)
Chinese	-0.044	-0.041	-0.063	-0.097
	(0.085)	(0.087)	(0.353)	(0.358)
Trusted Agent	-0.031	-0.037	0.032	0.080
	(0.082)	(0.089)	(0.243)	(0.174)
Age	0.001	0.001	-0.014***	-0.019***
	(0.002)	(0.002)	(0.006)	(0.006)
Gender	0.011	-0.004	-0.094	-0.202
	(0.040)	(0.040)	(0.139)	(0.141)
Education	-0.006	-0.006	-0.016	-0.027
	(0.006)	(0.006)	(0.019)	(0.018)
Farm/livestock	-0.029	-0.020	-0.059	-0.177
	(0.045)	(0.047)	(0.151)	(0.143)
Fishery	0.056	0.066	-0.123	-0.033
	(0.082)	(0.084)	(0.253)	(0.258)
Trade	-0.024	-0.028	-0.432***	-0.396***
	(0.051)	(0.051)	(0.155)	(0.148)
Business	-0.128*	-0.132*	-0.031	-0.014
	(0.068)	(0.069)	(0.230)	(0.228)
Government officer	-0.049	-0.043	-0.441**	-0.286
	(0.050)	(0.050)	(0.174)	(0.186)
Income (IV)	1.092		-30.939***	
			(11.779)	
Relative Income (IV)		-0.036		-0.000
		(0.057)		(0.220)
Mean Village Income (IV)		0.764		-55.431***
		(3.698)		(16.248)
Distance to market	0.007	0.005	-0.013	-0.049
	(0.016)	(0.016)	(0.052)	(0.051)
South	-0.038	-0.054	0.117	0.296
	(0.055)	(0.052)	(0.169)	(0.179)
Risk Payment	-1.152	-1.066	-11.135***	-13.404***
	(1.144)	(1.142)	(3.954)	(4.225)

Note: Number of observation is 5340 and adjusted R^2 is 0.524 in both regressions.
Note: *** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level. Standard errors are in parentheses.

Figure 1: Distribution of switching points in Series 1 & 2 (experimental data). Black denotes switching point pairs consistent with EU assuming constant relative risk-aversion (CRRA).

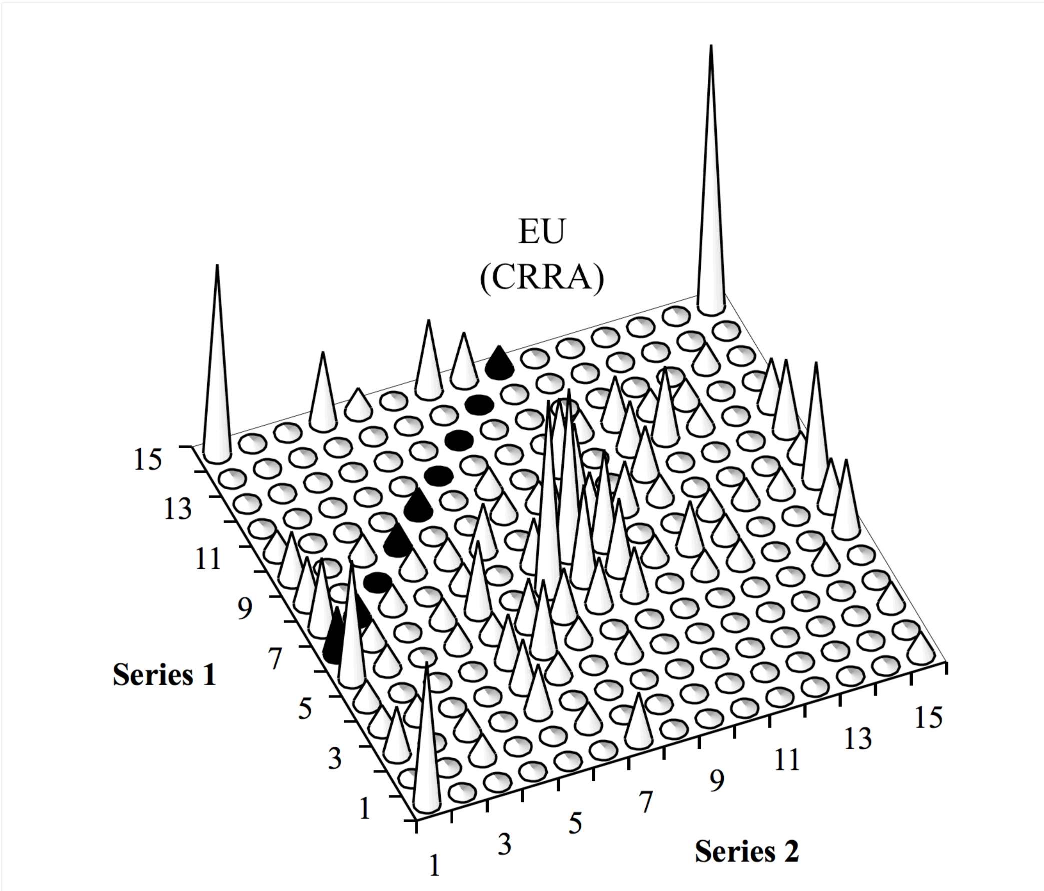
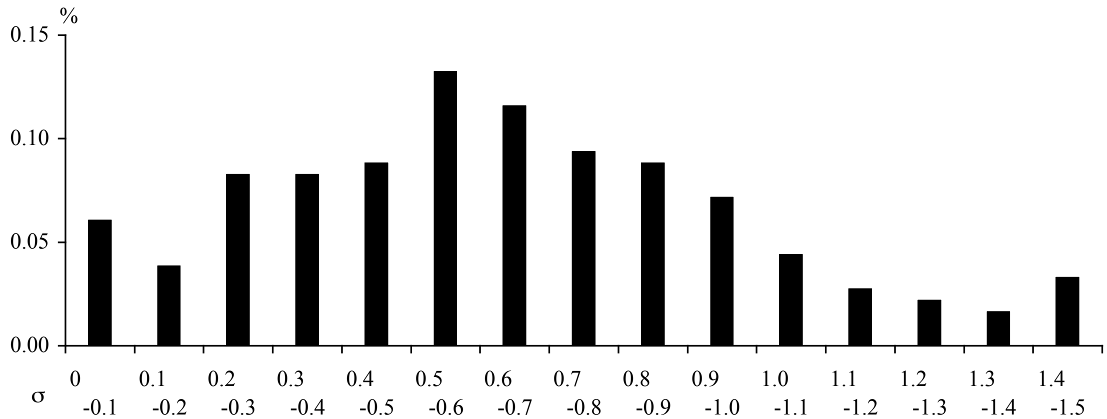
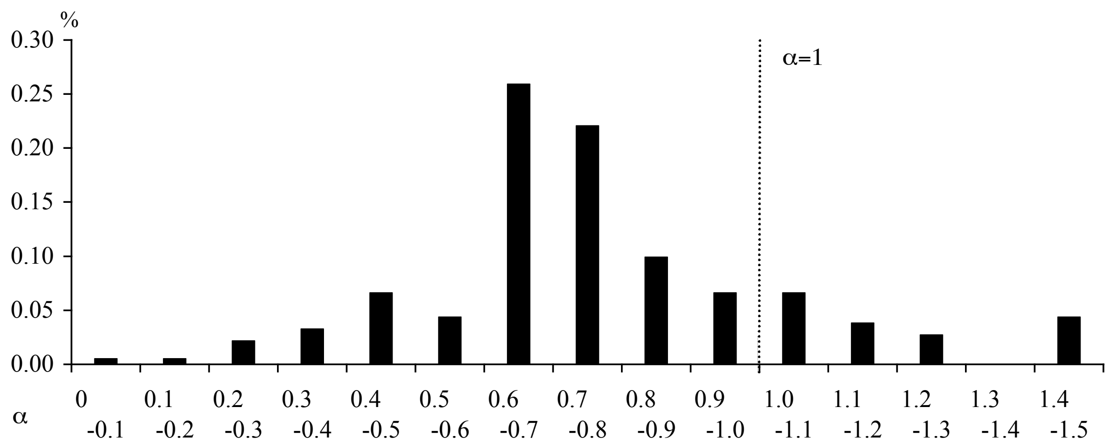


Figure 2: σ (parameter for the curvature of power value function), α (probability sensitivity parameter in Prelec's weighting function), and estimated λ (loss aversion parameter)

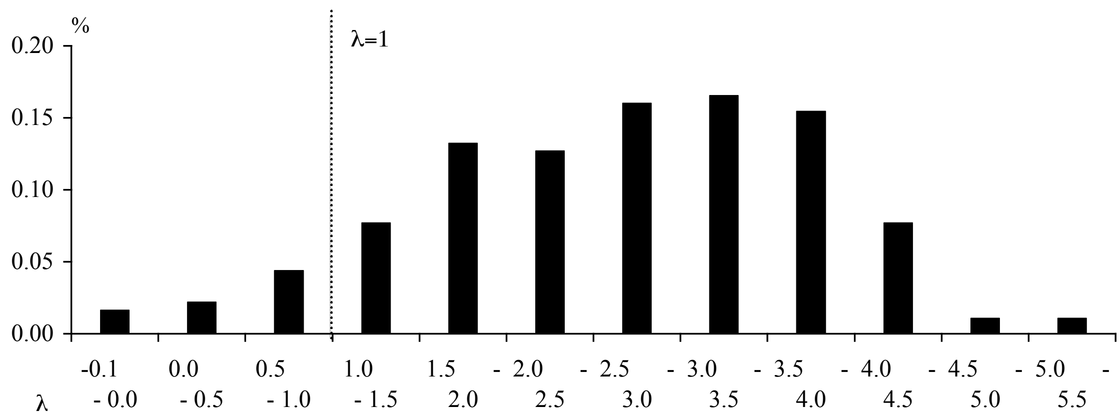
(1) σ (parameter for the curvature of power value function)



(2) α (probability sensitivity parameter in Prelec's weighting function)



(3) **Estimated λ (loss aversion parameter)**



Appendix

Table A.1: Switching point (question) in Series 1 and 2, and approximations of σ (parameter for the curvature of power value function) and α (probability sensitivity parameter in Prelec's weighting function)

σ	Switching question in Series 1														
Series 2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Never
1	1.50	1.40	1.35	1.25	1.15	1.10	1.00	0.95	0.90	0.85	0.80	0.75	0.65	0.55	0.50
2	1.40	1.30	1.25	1.15	1.10	1.00	0.95	0.90	0.85	0.80	0.75	0.70	0.60	0.55	0.50
3	1.30	1.20	1.15	1.10	1.00	0.95	0.90	0.85	0.80	0.75	0.70	0.65	0.55	0.50	0.45
4	1.20	1.15	1.05	1.00	0.95	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.50	0.45	0.40
5	1.15	1.05	1.00	0.95	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.40	0.35
6	1.05	1.00	0.95	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.45	0.40	0.35
7	1.00	0.95	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.45	0.40	0.35	0.30
8	0.95	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.45	0.40	0.35	0.30	0.25
9	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.45	0.40	0.35	0.30	0.25	0.20
10	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.45	0.40	0.35	0.30	0.25	0.20	0.20
11	0.80	0.70	0.65	0.65	0.60	0.55	0.50	0.45	0.40	0.35	0.30	0.25	0.20	0.15	0.15
12	0.75	0.65	0.60	0.55	0.50	0.50	0.45	0.40	0.35	0.30	0.25	0.20	0.20	0.15	0.10
13	0.65	0.60	0.55	0.50	0.45	0.45	0.40	0.35	0.30	0.25	0.20	0.15	0.15	0.10	0.10
14	0.60	0.55	0.50	0.45	0.40	0.35	0.35	0.30	0.25	0.20	0.15	0.10	0.10	0.10	0.05
Never	0.50	0.45	0.40	0.40	0.35	0.30	0.30	0.25	0.20	0.15	0.10	0.10	0.05	0.05	0.05

α	Switching question in Series 1														
Series 2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Never
1	0.60	0.75	0.75	0.85	0.90	0.95	1.00	1.05	1.10	1.15	1.20	1.25	1.30	1.40	1.45
2	0.60	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	1.10	1.15	1.20	1.25	1.35	1.40
3	0.55	0.60	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	1.10	1.15	1.20	1.25	1.30
4	0.50	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	1.10	1.15	1.20	1.25
5	0.45	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	1.10	1.15	1.20
6	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	1.10	1.15
7	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	1.10
8	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05
9	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00
10	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
11	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90
12	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85
13	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80
14	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75
Never	0.05	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.45	0.55	0.55	0.65	0.60

Note: σ and α are approximated to the nearest .05 increments. When subjects do not switch, the approximate values at the boundaries were used.

Table A.2: Pairwise time discounting choices

	Option A	Option B
1-1	Receive 120,000 dong in 1 week	Receive 20,000 dong today
1-2	Receive 120,000 dong in 1 week	Receive 40,000 dong today
1-3	Receive 120,000 dong in 1 week	Receive 60,000 dong today
1-4	Receive 120,000 dong in 1 week	Receive 80,000 dong today
1-5	Receive 120,000 dong in 1 week	Receive 100,000 dong today
2-1	Receive 120,000 dong in 1 month	Receive 20,000 dong today
2-2	Receive 120,000 dong in 1 month	Receive 40,000 dong today
2-3	Receive 120,000 dong in 1 month	Receive 60,000 dong today
2-4	Receive 120,000 dong in 1 month	Receive 80,000 dong today
2-5	Receive 120,000 dong in 1 month	Receive 100,000 dong today
3-1	Receive 120,000 dong in 3 months	Receive 20,000 dong today
3-2	Receive 120,000 dong in 3 months	Receive 40,000 dong today
3-3	Receive 120,000 dong in 3 months	Receive 60,000 dong today
3-4	Receive 120,000 dong in 3 months	Receive 80,000 dong today
3-5	Receive 120,000 dong in 3 months	Receive 100,000 dong today
4-1	Receive 300,000 dong in 1 week	Receive 50,000 dong today
4-2	Receive 300,000 dong in 1 week	Receive 100,000 dong today
4-3	Receive 300,000 dong in 1 week	Receive 150,000 dong today
4-4	Receive 300,000 dong in 1 week	Receive 200,000 dong today
4-5	Receive 300,000 dong in 1 week	Receive 250,000 dong today
5-1	Receive 300,000 dong in 1 month	Receive 50,000 dong today
5-2	Receive 300,000 dong in 1 month	Receive 100,000 dong today
5-3	Receive 300,000 dong in 1 month	Receive 150,000 dong today
5-4	Receive 300,000 dong in 1 month	Receive 200,000 dong today
5-5	Receive 300,000 dong in 1 month	Receive 250,000 dong today
6-1	Receive 300,000 dong in 3 months	Receive 50,000 dong today
6-2	Receive 300,000 dong in 3 months	Receive 100,000 dong today
6-3	Receive 300,000 dong in 3 months	Receive 150,000 dong today
6-4	Receive 300,000 dong in 3 months	Receive 200,000 dong today
6-5	Receive 300,000 dong in 3 months	Receive 250,000 dong today
7-1	Receive 30,000 dong in 1 week	Receive 5,000 dong today
7-2	Receive 30,000 dong in 1 week	Receive 10,000 dong today
7-3	Receive 30,000 dong in 1 week	Receive 15,000 dong today
7-4	Receive 30,000 dong in 1 week	Receive 20,000 dong today
7-5	Receive 30,000 dong in 1 week	Receive 25,000 dong today
8-1	Receive 30,000 dong in 1 month	Receive 5,000 dong today
8-2	Receive 30,000 dong in 1 month	Receive 10,000 dong today
8-3	Receive 30,000 dong in 1 month	Receive 15,000 dong today
8-4	Receive 30,000 dong in 1 month	Receive 20,000 dong today
8-5	Receive 30,000 dong in 1 month	Receive 25,000 dong today

(Continued)

	Option A	Option B
9-1	Receive 30,000 dong in 3 months	Receive 5,000 dong today
9-2	Receive 30,000 dong in 3 months	Receive 10,000 dong today
9-3	Receive 30,000 dong in 3 months	Receive 15,000 dong today
9-4	Receive 30,000 dong in 3 months	Receive 20,000 dong today
9-5	Receive 30,000 dong in 3 months	Receive 25,000 dong today
10-1	Receive 240,000 dong in 3 days	Receive 40,000 dong today
10-2	Receive 240,000 dong in 3 days	Receive 80,000 dong today
10-3	Receive 240,000 dong in 3 days	Receive 120,000 dong today
10-4	Receive 240,000 dong in 3 days	Receive 160,000 dong today
10-5	Receive 240,000 dong in 3 days	Receive 200,000 dong today
11-1	Receive 240,000 dong in 2 weeks	Receive 40,000 dong today
11-2	Receive 240,000 dong in 2 weeks	Receive 80,000 dong today
11-3	Receive 240,000 dong in 2 weeks	Receive 120,000 dong today
11-4	Receive 240,000 dong in 2 weeks	Receive 160,000 dong today
11-5	Receive 240,000 dong in 2 weeks	Receive 200,000 dong today
12-1	Receive 240,000 dong in 2 months	Receive 40,000 dong today
12-2	Receive 240,000 dong in 2 months	Receive 80,000 dong today
12-3	Receive 240,000 dong in 2 months	Receive 120,000 dong today
12-4	Receive 240,000 dong in 2 months	Receive 160,000 dong today
12-5	Receive 240,000 dong in 2 months	Receive 200,000 dong today
13-1	Receive 60,000 dong in 3 days	Receive 10,000 dong today
13-2	Receive 60,000 dong in 3 days	Receive 20,000 dong today
13-3	Receive 60,000 dong in 3 days	Receive 30,000 dong today
13-4	Receive 60,000 dong in 3 days	Receive 40,000 dong today
13-5	Receive 60,000 dong in 3 days	Receive 50,000 dong today
14-1	Receive 60,000 dong in 2 weeks	Receive 10,000 dong today
14-2	Receive 60,000 dong in 2 weeks	Receive 20,000 dong today
14-3	Receive 60,000 dong in 2 weeks	Receive 30,000 dong today
14-4	Receive 60,000 dong in 2 weeks	Receive 40,000 dong today
14-5	Receive 60,000 dong in 2 weeks	Receive 50,000 dong today
15-1	Receive 60,000 dong in 2 months	Receive 10,000 dong today
15-2	Receive 60,000 dong in 2 months	Receive 20,000 dong today
15-3	Receive 60,000 dong in 2 months	Receive 30,000 dong today
15-4	Receive 60,000 dong in 2 months	Receive 40,000 dong today
15-5	Receive 60,000 dong in 2 months	Receive 50,000 dong today